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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁵ : G06F 15/70	A1	(11) International Publication Number: WO 93/07581 (43) International Publication Date: 15 April 1993 (15.04.93)
(21) International Application Number: PCT/SE92/00695 (22) International Filing Date: 5 October 1992 (05.10.92) (30) Priority data: 9102892-8 7 October 1991 (07.10.91) SE (71) Applicant: TELEVERKET [SE/SE]; S-123 86 Farsta (SE). (72) Inventors: FENG, Yingduo ; Grindtorpsvägen 7, 9 tr, S-183 92 Täby (SE). ÖSTBERG, Olov ; Köpmannagatan 11, S-111 31 Stockholm (SE). (74) Agent: SOHLMAN, Leif; Telia Research AB, S-136 80 Haninge (SE).		(81) Designated States: AU, CA, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, SE). Published <i>With international search report.</i>
(54) Title: MEANS FOR MEASURING PICTURE QUALITY USING OPTICAL PATTERN RECOGNITION		
(57) Abstract The invention relates to means for measuring picture quality of various types of visual pictures and documents using optical pattern recognition. The means comprises an optical recognition equipment with adapted recognition sensitivity and an algorithm for calculation and analysis of error frequencies, together with a test pattern. The invention enables measuring an unknown test object, a picture or a document, using e.g. an OCR program with adapted recognition sensitivity in a reliable way with respect to readability and resolution.	 <p>Bokstäverna får sitt sanna behag inte när de skrivs i brådska och med olust inte heller när de kommer till blott genom flit och möda utan först då de skapas i kärlek och glädje.</p> <p>Giambattista Bodoni</p> <p>ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 1234567890</p> <p>ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 1234567890</p> <p>ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 1234567890</p> <p>ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 1234567890</p> <p>ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 1234567890</p> <p>ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 1234567890</p> <p>Sluppmässig ordning av dessa bokstäver</p> 	

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FI	Finland				

APPLICANT: TELEVERKET

TITLE OF INVENTION: MEANS FOR MEASURING PICTURE QUALITY USING
OPTICAL PATTERN RECOGNITION

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FIELD OF THE INVENTION

10 The present invention relates to means for objective measurement of picture quality and, more specifically, means for characterizing picture quality of various types of visual pictures and documents using optical pattern recognition.

15 The expression characterization of picture quality means that the picture quality is described with objective measures, such as the likelihood of a person confusing an intended character with another character within a character set system, the degree of accuracy in reproducing a grey scale gradient, the signal/noise ratio, MTFA (Modulation
20 Transfer Function Area) value, the likelihood of considering the overall picture quality of a given application acceptable, etc.

25 The term visual pictures and documents relates to visual information presented on information carriers in the form of e.g. paper documents, films, electrooptical displays.

 The term optical pattern recognition relates to an electrooptical system designed to determine automatically the presence of specific picture elements.

30 STATE OF THE ART

 Examples of known prior art of this type is optical character recognition (OCR), which is designed to recognize automatically alphanumerical characters (combinations of horizontal, vertical and slanted lines, closed and open
35 curves, etc.). If the character in question is not alphanumerical (but e.g. consists of EAN codes) this method is usually called Optical Mark Recognition (OMR).

 In certain applications the pattern recognition may be "absolute" in that the pattern in question is standardized,
40 which is the case in traditional OCR for alphanumerical

characters. In other applications it may be required that the pattern recognition is "relative", which means that the pattern recognition is relative to an ideal test picture specially designed for the application.

5 The OCR and OMR technique is based on a computer program designed to optimize the likelihood of classifying correctly an input character. This automatic character recognition requires that the input characters are of a certain minimum quality. They are not intended for operation with texts of
10 lower quality, since it has been found that if the recognition level is lower than approximately 90-95 % a too great manual supplementary work is required and, therefore, it is better to perform the whole character recognition (reading) manually.

15 So far, no one has used this technique of optical recognition to develop this for a measuring device for picture quality. No one has used the recognition degree, which may vary between 0 and 100 %, as an objective measure of picture quality. No one has used a test pattern containing a text and
20 a graphic picture, as a basis for OCR/OMR measurement of picture quality.

SUMMARY OF THE INVENTION

25 The present invention provides means for objective measurement of picture quality comprising, on one hand, an optical recognition equipment, and on the other hand a test pattern. The recognition equipment (e.g. a scanner with OCR/OMR software) has a calibrated recognition sensitivity and an algorithm for calculation and analysis of error frequencies. Further embodiments are set forth in the accompanying claims.

BRIEF DESCRIPTION OF THE DRAWINGS

35 The invention will now be described in detail with reference to the accompanying drawings, in which:

Fig. 1 shows a test pattern for facsimile printouts;
Fig. 2 shows an example of a set of test patterns; and
Fig. 3 shows an example of an analysis of misinterpretations.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

The present invention provides means for objective measurement of picture quality, mainly comprising an optical recognition equipment and test patterns. The optical recognition equipment, e.g. a scanner with OCR/OMR software, has a calibrated recognition sensitivity and an algorithm for calculation and analysis of error frequencies. The recognition degree is high when the picture quality is high. The recognition degree should be sufficiently low when the picture quality is low. The test patterns contain information in various directions such that the picture quality can be assessed in its entirety.

The following examples illustrate the construction and the use of the invention.

Example 1. In microfilming it is common that the first picture frame is a photograph of a standardized test picture. After development the photographed test picture is enlarged and it is examined with respect to its reproduction in an acceptable way in the filming process. Using the present invention the quality control may be performed automatically and in an objective way.

Example 2. Scanning a document for optical storage requires that the scanning equipment continuously is adjusted to enable optimal recording of e.g. lead pencil writing mixed with ballpoint pen writing and typewritten text. Using the present invention the quality control can be performed directly and automatically control the scanning equipment setting parameters to obtain optimal picture quality.

Example 3. In transmitting still pictures over the telephone network a picture telephone user using the present invention can establish if the picture quality of the document display equipment will be acceptable with ISDN coded transmission. The transmitting party can print using a video printer before a transmission a test pattern reproduction "frozen" in the document camera. Then the printout is input in the pattern recognition equipment in which it is scanned and characterized in accordance with the software selected, e.g. "57 % recognition degree in ISDN transmission of text having the typeface X and the character size Y".

Example 4. Telefax printouts may have different resolution in the horizontal and vertical direction. In order to characterize the resolution of telefax printouts an applicable test pattern is needed containing spatial information in both directions, as is shown in Fig. 1. To characterize readability of telefax printouts, on one hand, an adapted recognition sensitivity is required, and, on the other hand, an algorithm for prognostic calculation and analysis of misinterpreted elements. Calibration of sensitivity and recognition degree is in this case performed by means of a set of test patterns with well-defined physical test results, as is shown in Fig. 2.

The test patterns made with precision in laboratory environment, consist of a series of pictures having one and the same subject, e.g. a picture or a text, having varying picture quality. Each test pattern of the series is characterized, on one hand, by an objective picture quality measure, e.g. MTFA (Modulation Transfer Function Area), and on the other hand, by a subjective measure expressed as quality judgements as e.g. "excellent", "good", "acceptable", "poor" or "very poor". By means of a series of such test patterns a picture produced by means of any reproduction medium can be graded with respect to objective as well as subjective picture quality.

The prognostic analysis of the misinterpretation may appear as in Fig. 3, showing error frequencies in a readability test of a standard picture (Tele Nova Compis; normal face) and a test picture (IBM PC Color; bold face). The total average includes data of all 70 characters, but in the figure only values are shown for characters having an average error frequency greater than 3 % (100 % = 25 errors).

Example 5. The picture quality of a closed picture communication system can be monitored using the present invention and tested by the transmission side periodically transmitting a test picture known to the receiving side, which picture is analyzed there providing quality judgements to the receiving side. The same principle can be used in networks by several users and in open systems provided that the user collective has an internal standardized test pattern and associated test pattern analysis programs. A "quality hand-

shake" is obtained if the picture quality analysis is combined with automatic choice of e.g. channel band width in the ISDN network.

Thus, the present invention provides means automatically achieving an objective measurement of the quality of a picture or text. Specifically, values of the quality parameters readability and resolution are obtained. A measurement of the likelihood of misinterpreting a picture is obtained.

A person skilled in the art appreciates that the invention may be applied in several different ways. The examples above are not a complete recitation. The invention is only limited by the claims below.

CLAIMS

1. Means for objective measurement of picture quality of reproduction media using optical pattern recognition, **characterized** in that a pattern recognition equipment together with a test pattern are used to objectively measure and read the quality parameters readability and resolution of a picture or text.

2. Means according to claim 1, **characterized** in that measurement and characterization of the quality parameters readability and resolution of a picture or text are performed by prognostic calculation and analysis of misinterpreted elements.

3. Means according to claim 1, **characterized** in that the pattern recognition equipment with the test pattern, in dependence of the field of application, is adapted and calibrated with respect to recognition sensitivity and degree.

4. Means according to claim 1, **characterized** in that adaptation and calibration of the recognition sensitivity and degree is applied to a series of physical or electronical test patterns containing pictures and/or texts with varying and physically well-defined test results and the corresponding subjective expressions.

1/3

Bokstäverna får sitt sanna behag inte när de skrivs i brådska och med olust inte heller när de kommer till blott genom flit och möda utan först då de skapas i kärlek och glädje.

Giambattista Bodoni

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Slumpmässig ordning av dessa bokstäver

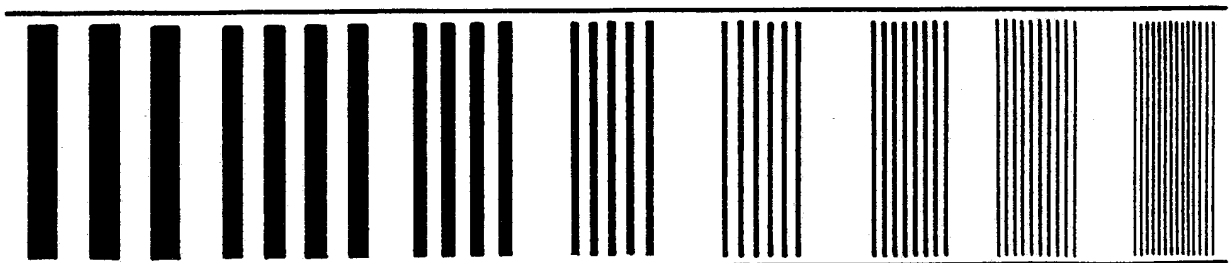


FIG. 1

Lingonen brukar mogna i september och sikten är ganska skymd i kurvan, men många trivs med att vandra i fjällen.

⋮

Lingonen brukar mogna i september och sikten är ganska skymd i kurvan, men många trivs med att vandra i fjällen.

⋮

Lingonen brukar mogna i september och sikten är ganska skymd i kurvan, men många trivs med att vandra i fjällen.

1. MTFA: 10,6
Picture quality:
Very good

2.

3. MTFA: 7,7
Picture quality:
Acceptable

4.

5.

6. MTFA: 5,4
Picture quality:
Very poor

7.

FIG. 2

SUBSTITUTE SHEET

RANK of	SUBJECTS																			
	High scores on reading test										Low scores on reading test									
MEANS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A 41-4	64	64	16	16	60	24	44		80	80	84	8	24	12	60	80	64	8	32	8
1 34-8	68	36	4	20	48	12	8		52	68		64	20	40	56	60	64	16	28	32
1 23-6	52	8	16	8	24	32	4	24	44	40	16	28	16	8	28	48	20	24	12	20
1 16-6	36	4		12	52	8	12	4	20	16	4	8	12		20	40	28	8	32	8
0 15-0	32	8	12	4	32	8	20	8	20	8	16	12	4	4	32	24	36	4	4	12
q 12-8	4		12	56	16	4	24	4	24	8	4	28			16	20	4	8	12	12
o 3-4	20	4	4	4		8			4	12			4	4	4	4	4		4	
K 3-2		4		4		20	8						4	4		4	16			
ä 3-0	4	4	4	4	4				4		4	8	4	4	12	4				
2-20	3-3	1-4	1-3	3-0	2-3	1-7	1-0	2-5	2-9	1-5	2-2	1-4	1-8	2-7	2-7	3-7	1-2	0-7	2-7	
3-05	3-4	1-6	2-3	4-4	3-4	2-7	1-5	3-8	4-0	2-8	2-4	2-5	1-4	3-9	5-4	4-6	1-8	2-1	2-5	
2-62	2-74										2-50									

FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 92/00695

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶ According to International Patent Classification (IPC) or to both National Classification and IPC IPC5: G 06 F 15/70										
II. FIELDS SEARCHED <div style="text-align: right; font-size: small;">Minimum Documentation Searched⁷</div> <table style="width: 100%; border: none;"> <tr> <td style="width: 20%; border: none; vertical-align: top; padding: 5px;"> <div style="border: 1px solid black; padding: 2px;">Classification System</div> </td> <td style="border: none; vertical-align: top; padding: 5px;"> <div style="border: 1px solid black; padding: 2px;">Classification Symbols</div> </td> </tr> <tr> <td style="border: none; vertical-align: top; padding: 5px;"> <div style="border: 1px solid black; padding: 2px;">IPC5</div> </td> <td style="border: none; vertical-align: top; padding: 5px;"> <div style="border: 1px solid black; padding: 2px;">G 06 F, G 06 K</div> </td> </tr> </table> <div style="text-align: center; font-size: small; margin-top: 5px;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched⁸</div> <div style="padding: 5px; margin-top: 10px;">SE,DK,FI,NO classes as above</div>			<div style="border: 1px solid black; padding: 2px;">Classification System</div>	<div style="border: 1px solid black; padding: 2px;">Classification Symbols</div>	<div style="border: 1px solid black; padding: 2px;">IPC5</div>	<div style="border: 1px solid black; padding: 2px;">G 06 F, G 06 K</div>				
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<div style="border: 1px solid black; padding: 2px;">IPC5</div>	<div style="border: 1px solid black; padding: 2px;">G 06 F, G 06 K</div>									
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹ <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%; font-size: small;">Category *</th> <th style="width: 60%; font-size: small;">Citation of Document,¹¹ with indication, where appropriate, of the relevant passages¹²</th> <th style="width: 30%; font-size: small;">Relevant to Claim No.¹³</th> </tr> </thead> <tbody> <tr> <td style="vertical-align: top; padding: 5px;">P,A</td> <td style="vertical-align: top; padding: 5px;"> EP, A2, 0461793 (AMERICAN TELEPHONE AND TELEGRAPH COMPANY) 18 December 1991, see the whole document <div style="text-align: center; margin-top: 20px;">-----</div> </td> <td style="vertical-align: top; padding: 5px; text-align: center;">1-3</td> </tr> </tbody> </table>			Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	P,A	EP, A2, 0461793 (AMERICAN TELEPHONE AND TELEGRAPH COMPANY) 18 December 1991, see the whole document <div style="text-align: center; margin-top: 20px;">-----</div>	1-3		
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<div style="font-size: small;"> * Special categories of cited documents:¹⁰ <div style="display: flex; justify-content: space-between;"> <div style="width: 48%;"> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 48%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p> </div> </div> </div>										
IV. CERTIFICATION <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none; vertical-align: top; padding: 5px;"> <div style="border: 1px solid black; padding: 2px;">Date of the Actual Completion of the International Search</div> </td> <td style="width: 50%; border: none; vertical-align: top; padding: 5px;"> <div style="border: 1px solid black; padding: 2px;">Date of Mailing of this International Search Report</div> </td> </tr> <tr> <td style="border: none; vertical-align: top; padding: 5px;"> <div style="border: 1px solid black; padding: 2px;">17th December 1992</div> </td> <td style="border: none; vertical-align: top; padding: 5px;"> <div style="border: 1px solid black; padding: 2px;">18 -01- 1993</div> </td> </tr> <tr> <td style="border: none; vertical-align: top; padding: 5px;"> <div style="border: 1px solid black; padding: 2px;">International Searching Authority</div> </td> <td style="border: none; vertical-align: top; padding: 5px;"> <div style="border: 1px solid black; padding: 2px;">Signature of Authorized Officer</div> </td> </tr> <tr> <td style="border: none; vertical-align: top; padding: 5px;"> <div style="border: 1px solid black; padding: 2px;">SWEDISH PATENT OFFICE</div> </td> <td style="border: none; vertical-align: top; padding: 5px;"> <div style="border: 1px solid black; padding: 2px;">JAN SILFVERLING</div> </td> </tr> </table>			<div style="border: 1px solid black; padding: 2px;">Date of the Actual Completion of the International Search</div>	<div style="border: 1px solid black; padding: 2px;">Date of Mailing of this International Search Report</div>	<div style="border: 1px solid black; padding: 2px;">17th December 1992</div>	<div style="border: 1px solid black; padding: 2px;">18 -01- 1993</div>	<div style="border: 1px solid black; padding: 2px;">International Searching Authority</div>	<div style="border: 1px solid black; padding: 2px;">Signature of Authorized Officer</div>	<div style="border: 1px solid black; padding: 2px;">SWEDISH PATENT OFFICE</div>	<div style="border: 1px solid black; padding: 2px;">JAN SILFVERLING</div>
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**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. PCT/SE 92/00695**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the Swedish Patent Office EDP file on **02/12/92**
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A2- 0461793	91-12-18	CA-A- 2043593 JP-A- 4233094	91-12-13 92-08-21